Energy and Climate: Realizing Information Potentials to Help Get Climate Responses Right

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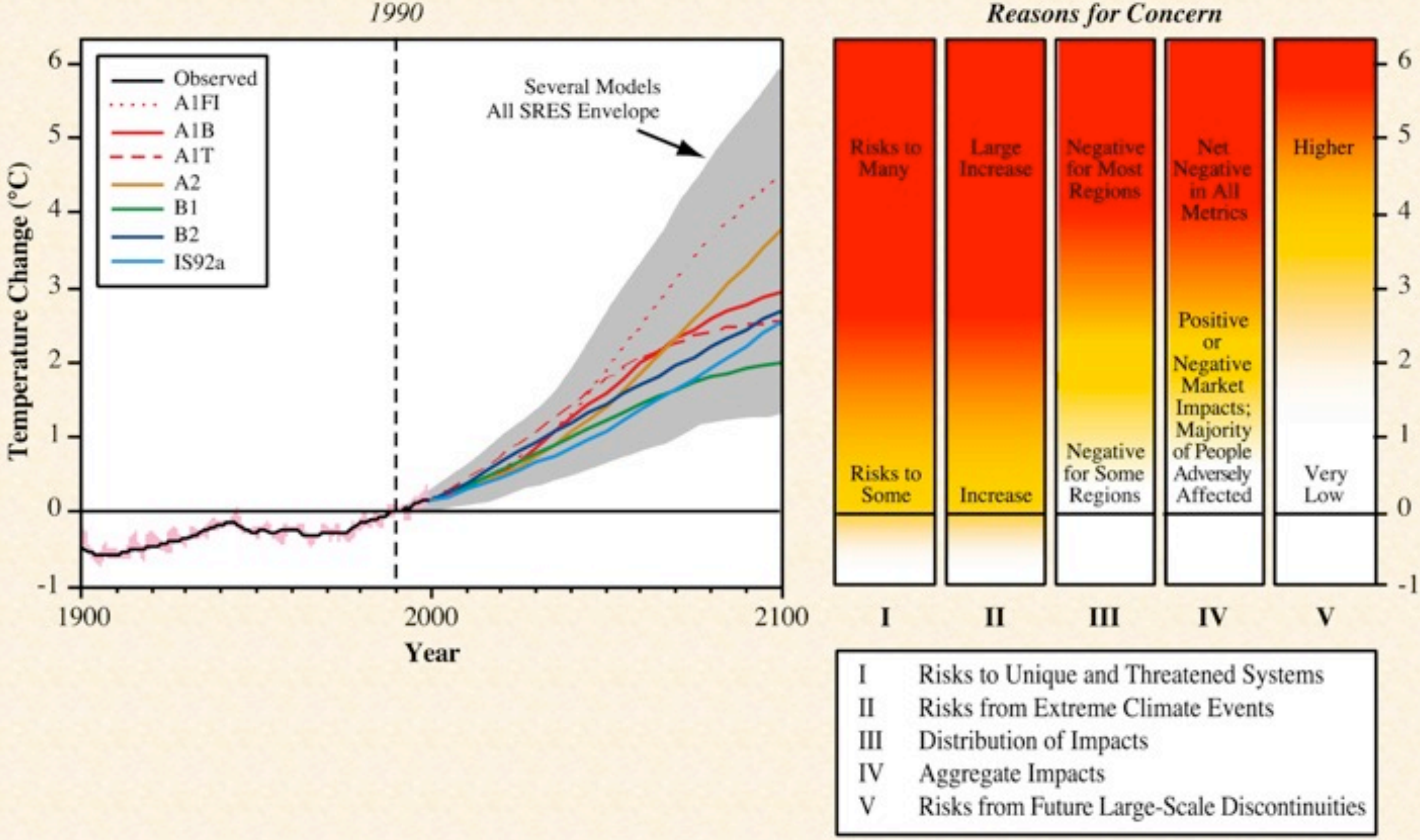
Avoiding Serious Impacts from Climate Change Will Be Virtually Impossible Unless We Dramatically Improve Our Response Options, Which Depends on Vastly Improving Our Ability to Inform Decisions About Them :

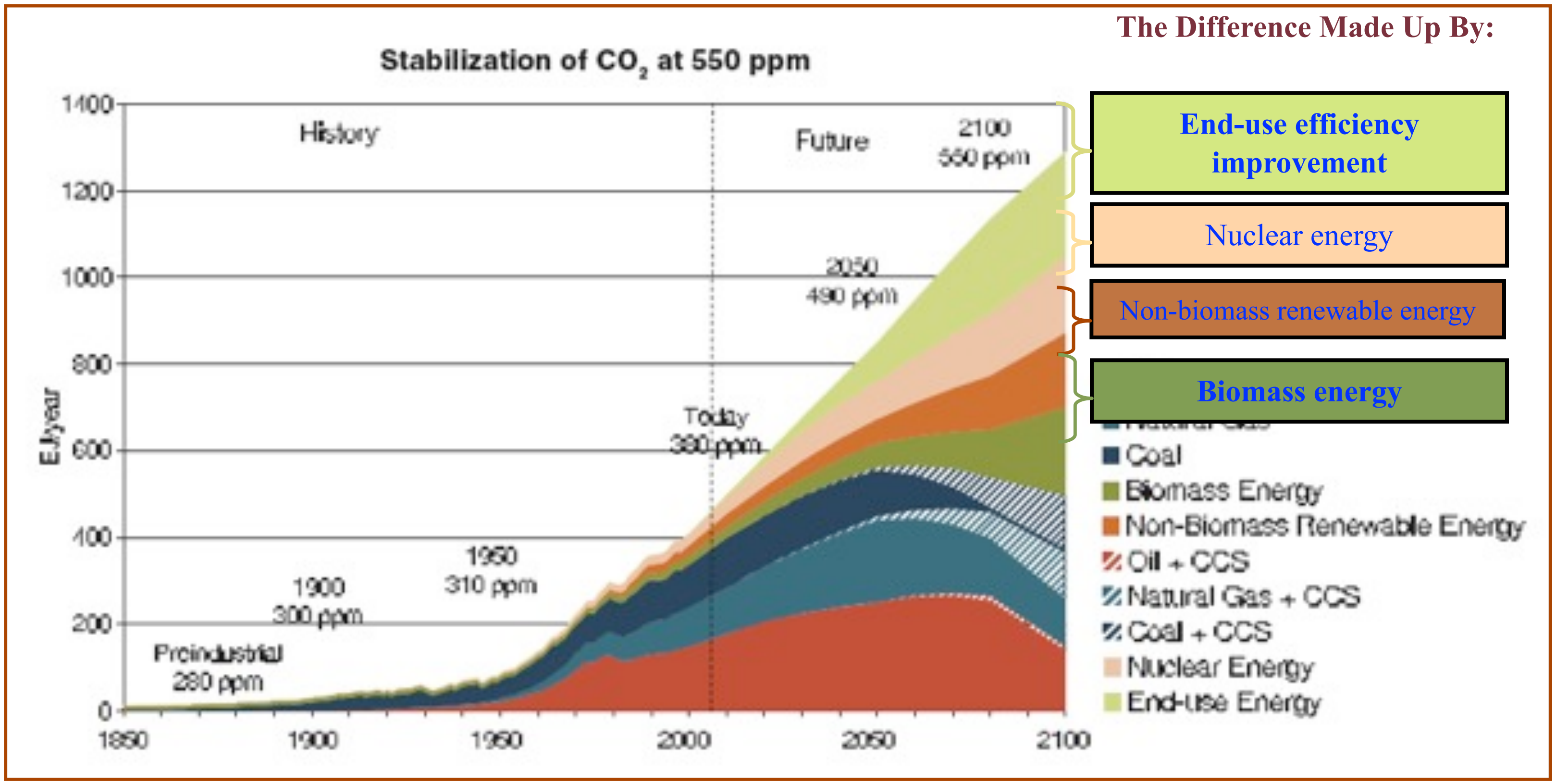
- ***Severe*** **climate change now appears to be a more likely future than** ***moderate*** **climate change**
- **Avoiding such a future is a profound challenge both for acquiring information and for communicating it effectively – and soon**
- **Information professionals (and those who support their work) will play critical roles in determining whether we are successful or not**

Setting the Context for Sorting Through the Connections:

- **Sustainable development vulnerabilities involve three dimensions:**
  - Exposure to threats
  - Sensitivity to threats
  - Capacity to cope with threats
- **Climate change vulnerabilities are shaped considerably by the magnitude of the exposure dimension, e.g.:**
  - Limited climate change: e.g., stabilizing GHG concentrations below 350 ppm – no more than 1-2 degrees C global mean temperature increase
  - Moderate climate change: e.g., stabilizing GHG concentrations at 450 ppm, or at most 550 ppm – mean temperature increase of 2.5 - 4 degrees C
  - Severe climate change: e.g., stabilizing GHG concentrations at 650 to 850 ppm, or higher (or not) – mean temperature increase of 5 – 8 degrees C or higher


1990
Reasons for Concern
Temperature Change (°C)
Observed
A1FI
A1B
A1T
A2
B1
B2
IS92a
Several Models
All SRES Envelope
Year
1900
2000
2100
Risks to Many
Large Increase
Negative for Most Regions
Net Negative in All Metrics
Higher
Positive or Negative Market Impacts; Majority of People Adversely Affected
Risks to Some
Increase
Negative for Some Regions
Very Low
I
II
III
IV
V
I Risks to Unique and Threatened Systems
II Risks from Extreme Climate Events
III Distribution of Impacts
IV Aggregate Impacts
V Risks from Future Large-Scale Discontinuities

What Does This Imply For Energy Policy And Technology -- Technology Uses To Stabilize At 550 ppm?

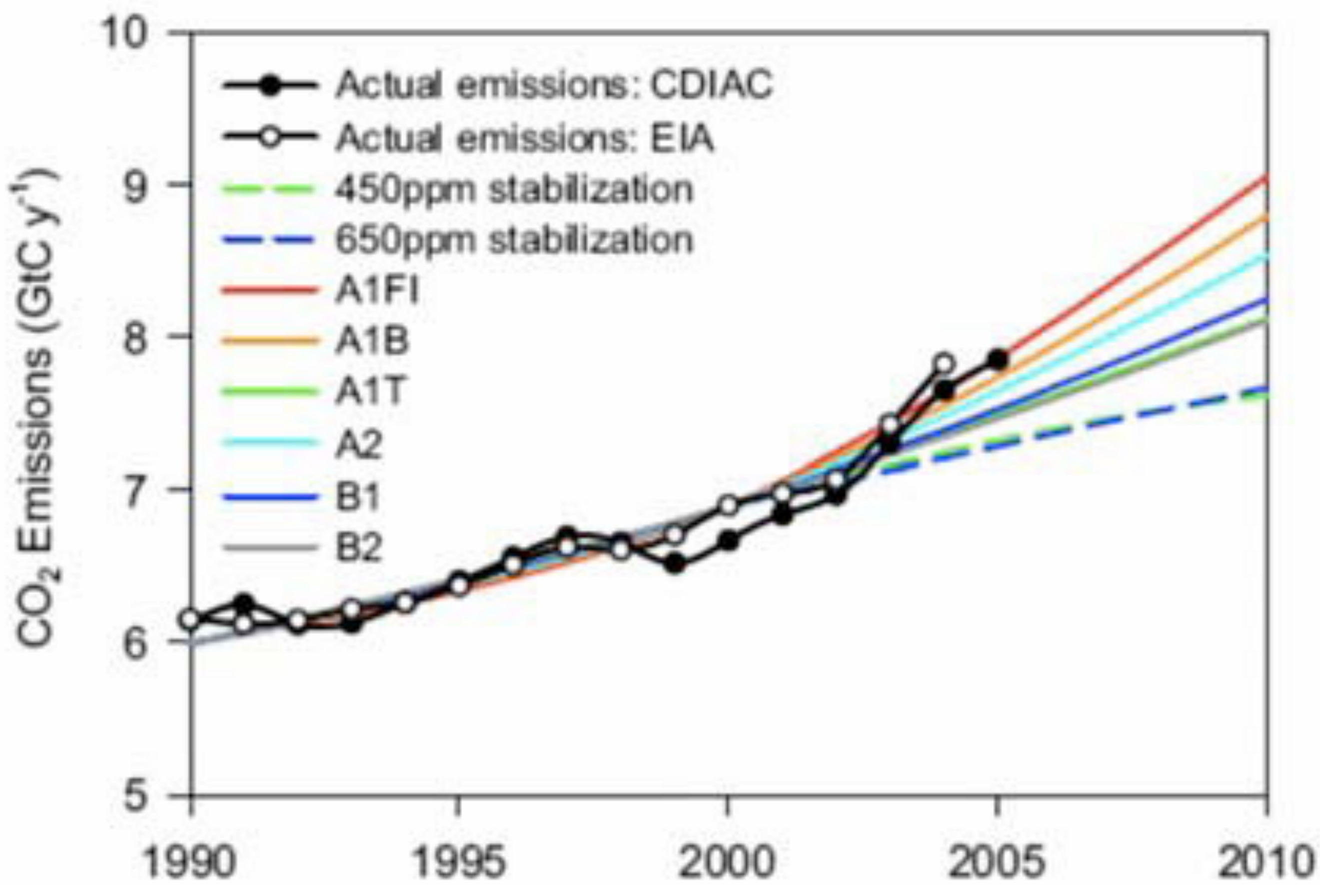


As Daunting As That Challenge Would Be, Expectations Are Already Changing Rapidly About Climate Change Impact Vulnerabilities And Risks In The Future:

- **Impacts are already emerging more rapidly than predicted even 5-10 years ago**

- **We are currently on a path that is worse than any scenario ever considered (until very recently)**

Why Worry?



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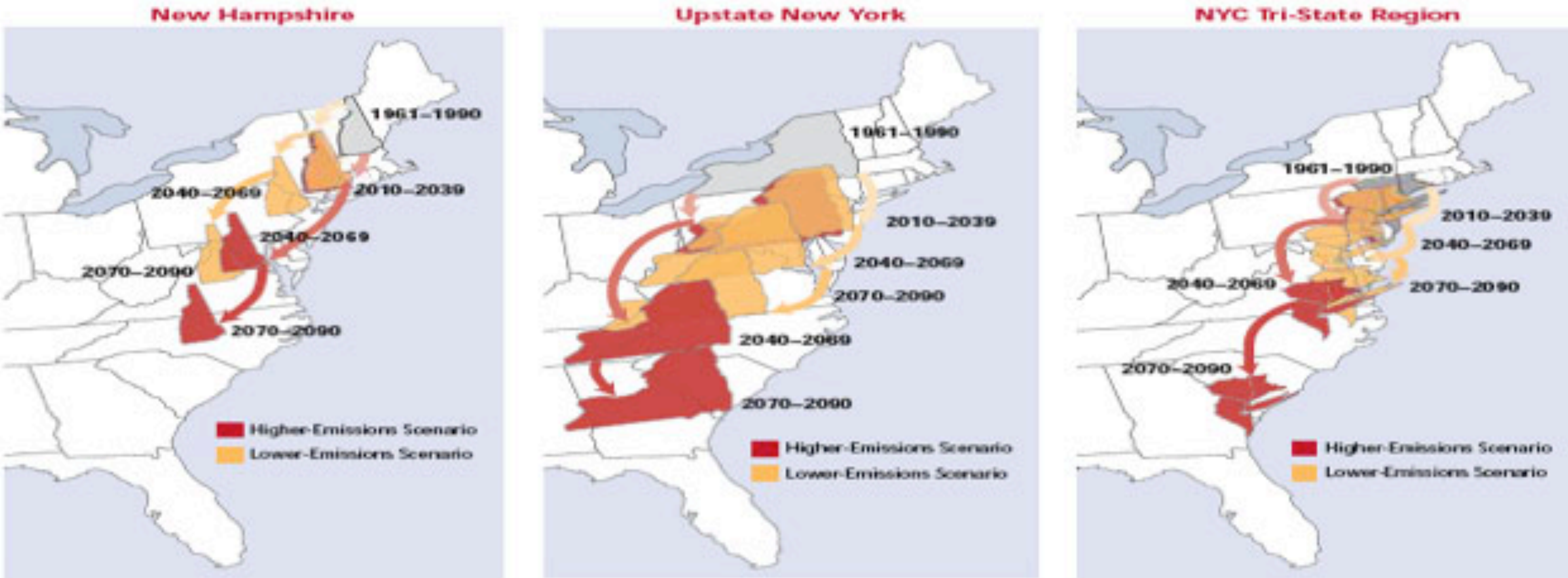
Scenarios ("RCPs") That Have Recently Been Developed For IPCC Show Much More Severe Climate Change Than Previously Considered (*Nature*, February 11, 2010)

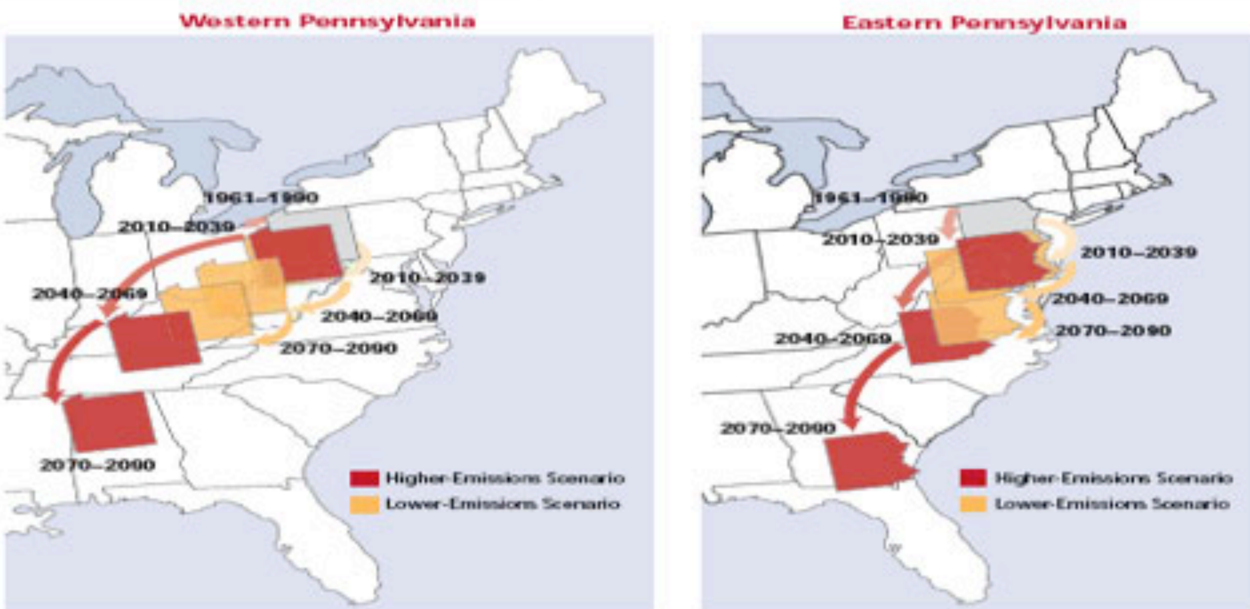
- **Lower <u>bound</u> overshoot (not likely to be achievable): ~450 ppm**
- **Mid-range stabilization scenarios in a 650-860 ppm range**
  - **Would probably mean warming in 5-8^{o}C range**
  - **Would mean dangerous, even catastrophic impacts for many regions and sectors**
- **Upper <u>bound</u> rising (unlikely business as usual): above 1300 ppm**

Consider Some Recent Projections Of An A1fi-type Future For Nine New England States:

http://www.northeastclimateimpacts.org

FIGURE 2: Migrating State Climates

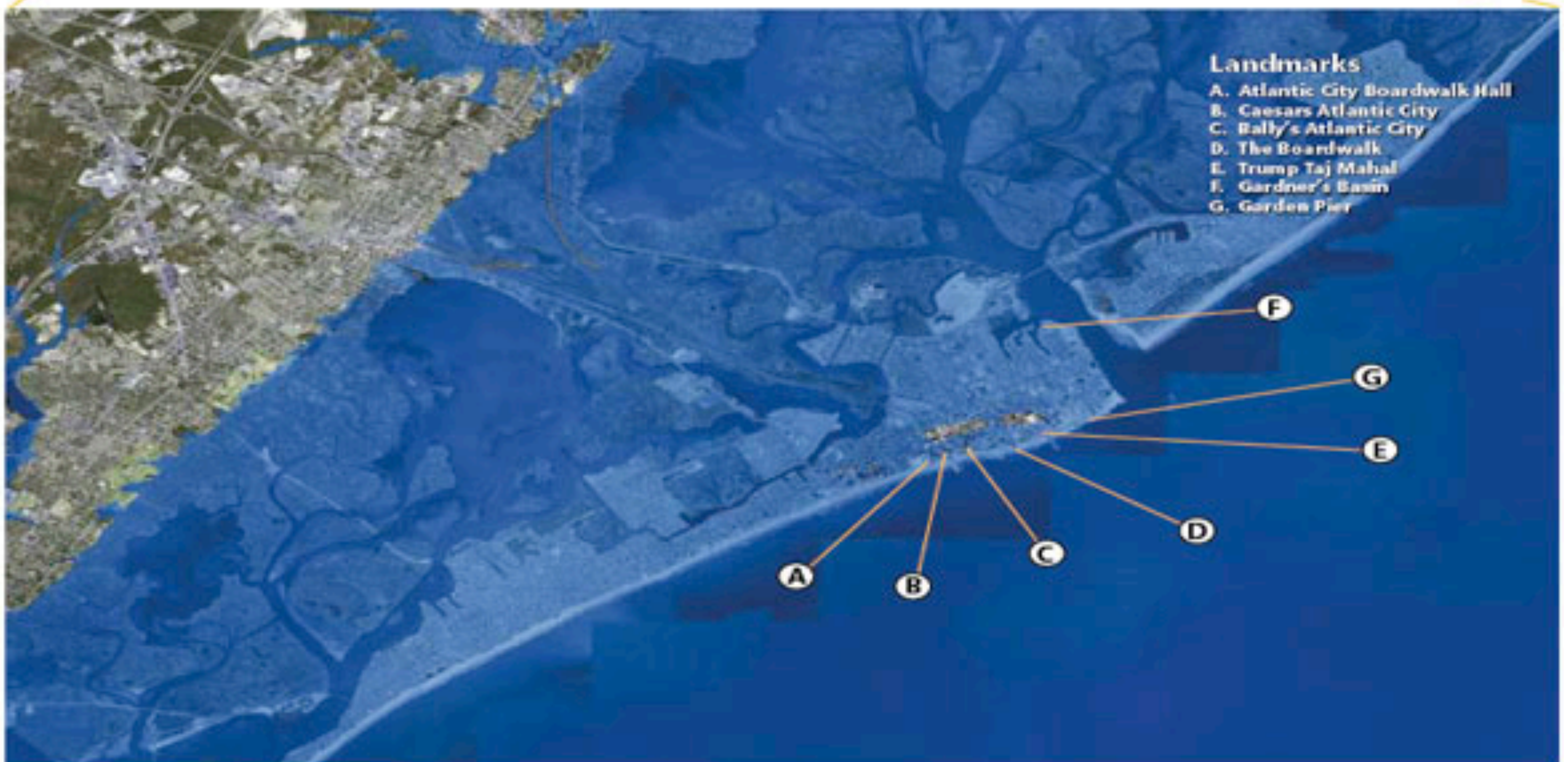




Changes in average summer heat index—a measure of how hot it actually feels, given temperature and humidity—could strongly affect quality of life in the future for residents of the Northeast. Red arrows track what summers could feel like in, for example, the NYC Tri-State region (the greater New York City metropolitan region, encompassing parts of New Jersey and Connecticut) over the course of the century under the higher-emissions scenario. Yellow arrows track what summers in these states would feel like under a lower-emissions scenario.

Atlantic City: Today's 100-Year Flood Could Become a Two-Year Flood by 2100

The top image shows the location of Atlantic City, NJ, on Absecon Island. The light blue area in the bottom image depicts today's FEMA 100-year flood zone (which extends beyond the area shown). Currently, this area has a 1 percent chance of being flooded in a given year. By 2100, this approximate area is projected to flood, on average, once every year or two under either emissions scenario, inundating high-tourist-value hotels and casinos. Under the higher-emissions scenario, the new 100-year flood height would be roughly four feet greater in 2100 than today, flooding a far greater area than the current FEMA flood zone.



This Situation Is Very Sobering:

- **The climate of 2030 has already been determined by emissions to date**
- **The climate of 2070 will be determined by emissions between now and 2030, but prospects for major changes in trends in the next two decades are not bright**
- **450 ppm stabilization (<3°C average warming) – traditionally considered the ceiling for coping – is almost certainly no longer achievable**
- **Most likely, we have already accepted such impacts as the acidification of the oceans, the loss of Arctic ice, and the loss of very large numbers of biological species**

What Are Our Options?:

- **Response options are:**
  - "Mitigation:" reducing exposures by reducing GHG emissions
  - "Adaptation:" reducing sensitivities and/or improving coping capacities
  - "Geoengineering:" intervening in earth systems to reduce solar radiative forcing or increase carbon uptakes
- **Both mitigation and adaptation are needed, and they support each other:**
  - Mitigation is essential to keep climate change moderate, but impacts cannot be avoided and progress is slow – so M needs A
  - Adaptation is essential to cope with impacts, but some impacts will test limits of adaptation – so A needs M

But the Challenges Are Truly Daunting:

- **Stabilizing greenhouse gas emissions at a relatively moderate level requires quick responses to two challenges:**
  - **Very substantial reductions in emissions by the US and other industrialized counties within several decades**
  - **Stabilization of emissions from China, India, and other rapidly developing economies without sacrificing economic growth**
- **The certainty of substantial regional, sectoral, and social impacts means that adaptation is inescapable**
  - **Considerable potentials and co-benefits, but mobilization has hardly begun**
  - ***Limits* to adaptations are much more likely with more severe climate change (IPCC SREX special report under way…)**

And International Perspectives on Responses Are Diverging:

- **At the Copenhagen COP this past December:**
  - **Big countries, both industrialized and developing, focused on finding a way to make progress in reducing the rate of growth in GHG emission reductions, aiming for stabilization not too far above 450 ppm**
    - **Voluntary commitments, not enforceable treaty agreements**
    - **Depending on observations to support social pressure… -- verification is a challenge of considerable interest in the remote sensing community**
  - **Small developing countries focused on dramatic limitations on emissions plus major support for adaptation, aiming for stabilization below 350 ppm**
    - **Said that the big country approach means catastrophes for many small countries, such as low-lying island nations**
    - **Promised growing future opposition to international agreements that do not meet their needs**

Is Global Emission Reduction Possible?

- The Asian dilemma: GHG emission growth increasingly driven by China and India, but energy is a key to their development
- Both expected to more than double their energy use between 2004 and 2030 – from 10% of world energy consumption in 1990 to 25% in 2030 (only 40 years)
- Domestic coal projected to supply 80% of electricity in China and 70% in India in 2030
- Realistic alternatives are difficult to find, but they may include:
  - Pushing efficiency improvement and natural gas use in place of coal (but foreign policy implications of possible energy dependence on Russia?)
  - Accelerating innovative energy technological change – and demonstrations by industrialized countries: e.g., carbon capture and storage (but time lag)
  - Encouraging development incentives for accelerated technology shifts, e.g.:
    - Partnerships, including sharing of intellectual property (IPR obstacles)
    - Market incentives for Asian technology leadership (China and solar energy?)

How Can Technological Change Be Accelerated as an Essential Part of the Answer? (I)

- **Accelerating energy technological change as an essential part of the answer: a need for transformational innovation**
  - **A recent analysis at ORNL concluded that meeting U.S. goals of both climate protection and energy security requires a high probability of success for all 11 energy technologies considered – a long shot at best**
  - **In fact, there is a growing sense of urgency about "transformational" energy technological change – not eventually, but soon: calls for national commitments comparable to the Apollo mission to the moon or the Manhattan project**
  - **The issue is how to induce discoveries, not just incremental changes: e.g, the role of DARPA in the IT revolution – ARPA-E???**
  - **But transformational *discoveries* will have to be coupled with unprecedentedly innovative *transitions* to the new technologies if they are going to be in time to avoid disruptive impacts**

How Can Technological Change Be Accelerated As an Essential Part of the Answer? (II)

- **Accelerating energy technological change as an essential part of the answer: broadening global engagement in the search**
  - Chances of a technology breakthrough are greater if we can reach and mobilize the best talent globally in the discovery process
  - This requires transferring to them what current science and technology knows and does, to be integrated with local knowledge to stimulate distributed discovery and innovation
  - The information technology revolution can be a powerful enabler of access to S&T knowledge, if intellectual property rights obstacles can be overcome

The Connections with Information Are Unavoidable:

- Raising awareness of the need for transformational change
  - Communicating the urgency
  - Monitoring and reporting what is happening – trends, emerging impacts – as a basis for adaptive action
- Accelerating the pace of discovery by mobilizing more talent to make it happen
  - Getting current scientific and technical knowledge spread much more widely – and quickly (transcending IPR issues…)
  - Spotting good ideas and accelerating their development
- Getting new options into use more quickly than we currently know how to do
  - Informing public opinion that shapes policy environments
  - Informing consumer choices

What Are the Core Information Challenges?(I):

- **Getting the right science, not just getting the science right:**
  - **Informing S&T agendas, not just using what emerges**
  - **Recognizing that current agendas for S&T, including current data systems, were designed to meet needs of the *past***
- **Improving our ability to connect science and decisions:**
  - **Two very important recent NAS/NRC reports:**
    - **NAS/NRC, *Informing Decisions in a Changing Climate*, 2009**
    - **"Informing Effective Decisions about Climate Change," panel report of the NAS Committee on America's Climate Choices, July 2010**
  - **One lesson: effective decision support depends on iterative interactions between top-down information suppliers and bottom-up information users**

What Are the Core Information Challenges?(II):

- **Meeting needs and challenges related to data integration**
  - Sensor-based data (space and in-situ) with other data
  - Environmental data with socioeconomic data
- **Recognizing that knowledge co-evolves from a combination of science and experience:**
  - Improving our ability to learn from experience as well as scientific observation and research…
  - At the same time, (a) using experience to guide evolving observation and research agendas and (b) using fruits of observation and research to inform evolving practices

The Potentials for Strengthening the Role of Information Are Expanding Rapidly:

- **The IT revolution, which has changed the world of information access and exchange: hardware and software**
- **The emerging science of "informatics:"**
  - From relational data bases to the semantic web: query-based searches (accessing sources that are pre-electronic?)
  - Mushrooming options for visualization
  - Rapidly growing capacities for interactivity
- **New approaches for "user assists", e.g.:**
  - Expert system shells
  - Simplified "community" modeling platforms for user experimentation

Realizing These Potentials to Help Get Climate Change Responses Right Needs Agency Support:

- **Program and management support:**
  - **Human resource challenges in agencies as well as in the research community**
  - **Support at all levels: the "social benefits of earth observing systems" example…**
  - **Including a wider range of agencies, including those involved in drivers and impacts: DOE, DOI, DOD, DHS, HUD, In, …**
- **The move toward national climate services: an emerging focus:**
  - **Pioneering sophisticated pathways for connecting scientific data and knowledge with user needs**
  - **Engaging programs at all levels – and pursuing stronger program-user interfaces**